A GLACIAL GEOLOGY AND PETROGRAPHIC STUDY OF THE ERRATIC AT OHIO STATE UNIVERSITY MARION BRANCH CAMPUS

by

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This paper was done in partial fulfillment
for the B.S. degree in Geology

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Introduction

One of the purposes of this thesis is to enable a student with very little geology background to read this paper and understand what an erratic is, where this erratic came from, at what time in the past it was brought to Marion County, what a thin section is and what it is used for, and basically what minerals this erratic is composed of. Most students at the Marion Branch Campus of Ohio State University do not have much, if any, geology background. For these reasons I want to keep this report simple and easy to understand. Another reason for this thesis is I have always wanted to know more about the erratic. Ever since I became interested in geology at Marion Branch Campus, I've wondered about that erratic in the field, but never have had the time to do any research on it. Also I would like to get more people at the Marion Branch Campus of Ohio State University to realize that the erratic is there. When I went to the school to see if I could get permission to break off a sample, I would usually get the same answer, "What boulder, where?" Hopefully, this thesis will also get some of the students at the Marion Branch Campus of Ohio State University more interested in geology and to plan a few field trips or go on some of the ones sponsored by the Geology Club here in Columbus. All this and the fact that I want to put a copy of this thesis in the library at the Mation Branch Campus of Ohio State University are reasons why I have used many maps, pictures, and illustrations.

In the glacial geology part of this paper, I will assume that the erratic is on a certain known glacial structure of a certain glacial age and then give characteristics of it, the soil, and the topography. In the petrographic part, I will do just the opposite. First I will study the thin section and give characteristics of the minerals within the erratic, then I will give a rock name to the erratic based on these characteristics.

Location of Subject

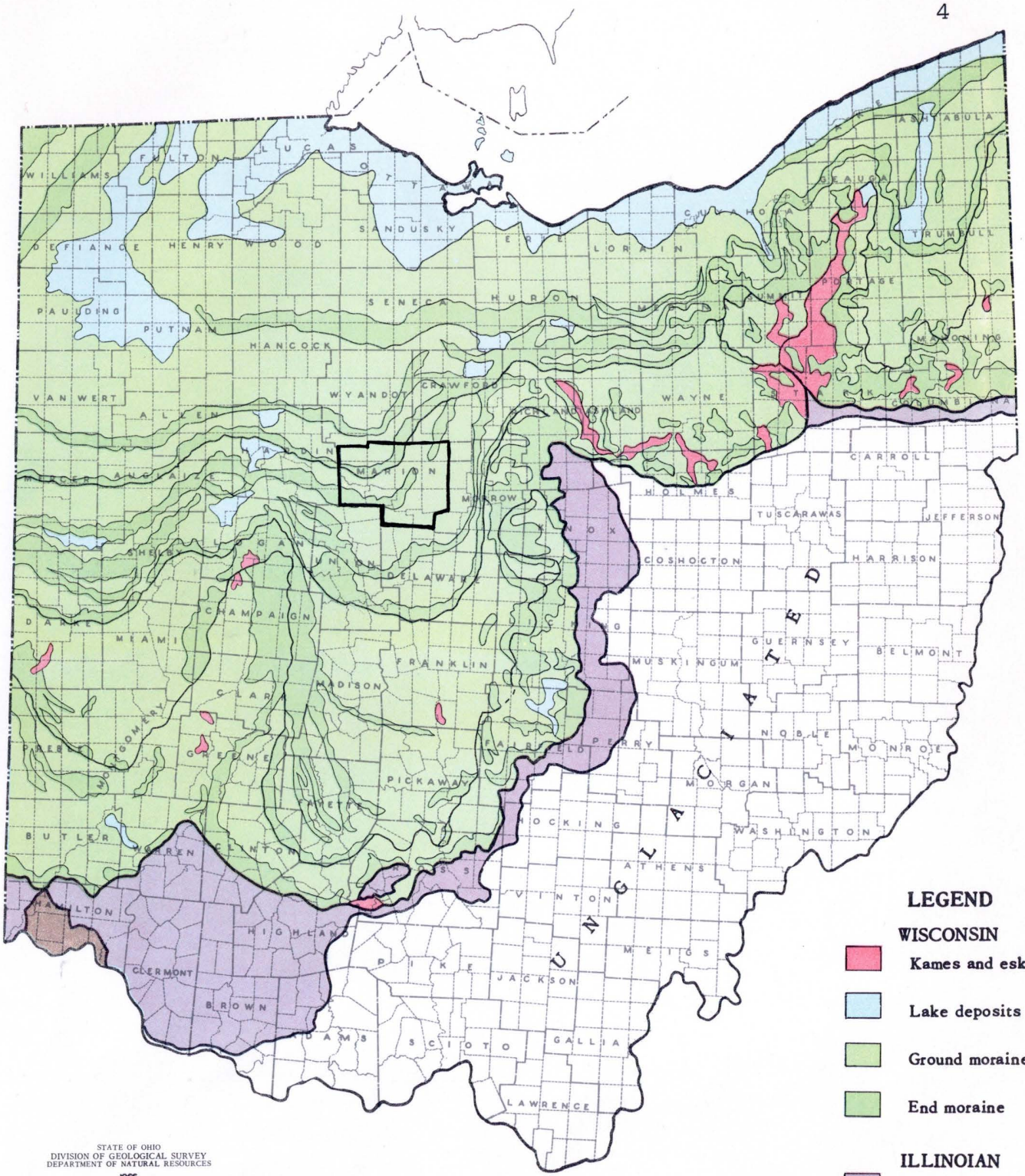
Marion County, Ohio, lies just northwest of the center of the state and about 45 miles north of Columbus. It is bounded on the north by Wyandot and Crawford Counties, on the east by Morrow County, on the south by Delaware and Union Counties, and on the west by Hardin County. It covers four-hundred and nine square miles or 261,760 acres. It lies completely within the glaciated region of Ohio (see maps, pages 3 and 4). Marion, Ohio, is located a little eastward of the center of the county. The Marion Branch Campus of The Ohio State University is located east and a little south of Marion along route 95 just outside the city limits (see maps, pages 5 and 6).

The boulder that I will discuss is in the field in front of the Marion Branch Campus of Ohio State University just to the northeast of the building (see photos, page 7). There are no other large boulders near this one so if you go to the school to look at it you won't mistake it for another. There are a couple of smaller boulders at the base of the larger one, but I did not include them in this paper because they didn't seem important to

Map # 1

glaciated area [red hatched box]

shows location of Ohio and the city of Marion within the glaciated region of North America



LEGEND

WISCONSIN

- Kames and eskers
- Lake deposits
- Ground moraine
- End moraine

ILLINOIAN

- Undifferentiated

KANSAN

- Ground moraine

STATE OF OHIO
DIVISION OF GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
1966

10 0 10 20 30 miles
Scale

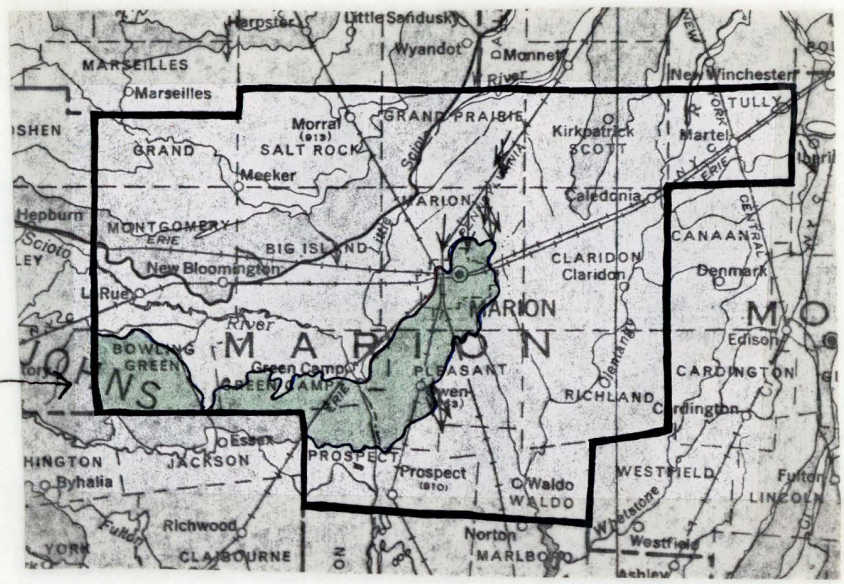
ADAPTED FROM GLACIAL MAP OF OHIO,
U.S. GEOL. SURVEY MISC. GEOL. INV. MAP I-316

GLACIAL DEPOSITS OF OHIO

Shows location of Marion County within the glaciated region of Ohio

Map # 2

St Johns Moraine



Map # 3 shows location of the city of Marion within Marion County

Map # 4 shows location of the Marion Branch Campus of Ohio State University with relation to the city of Marion

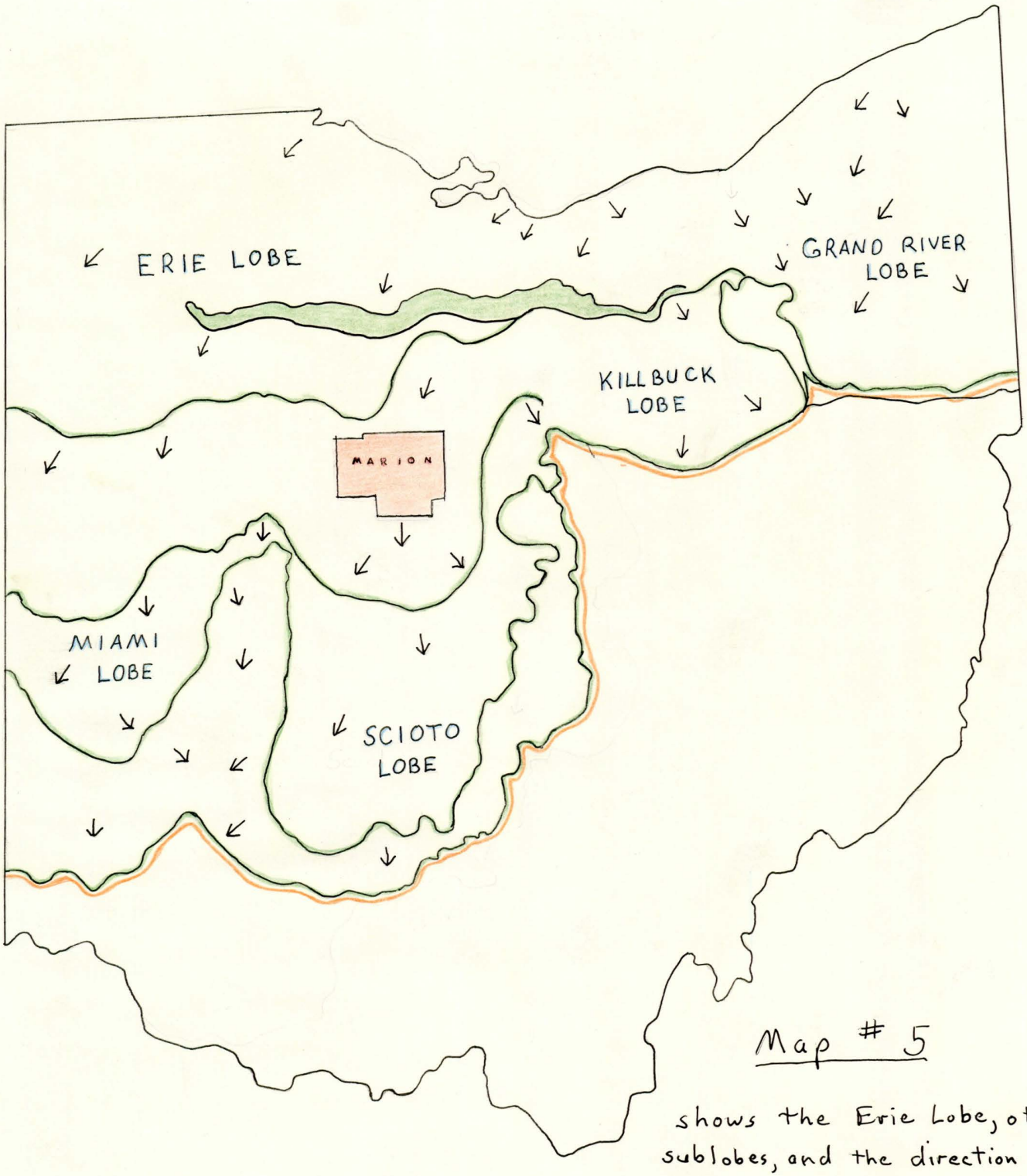
my research. This large boulder is called a glacial erratic, or simply an erratic. An erratic is any rock or boulder that has been broken off or plucked by a glacier from the bedrock where it was formed, then transported and deposited by the glacier on material usually of different composition far away.

Glacial Geology Report

In this glacial geology report I will include the glacial age and glacier associated with Marion County, where the erratic came from, what direction the glacier advanced, what time in the past it was deposited, a description of the soil around the Marion Branch Campus of Ohio State University and the erratic, and the topographical features.

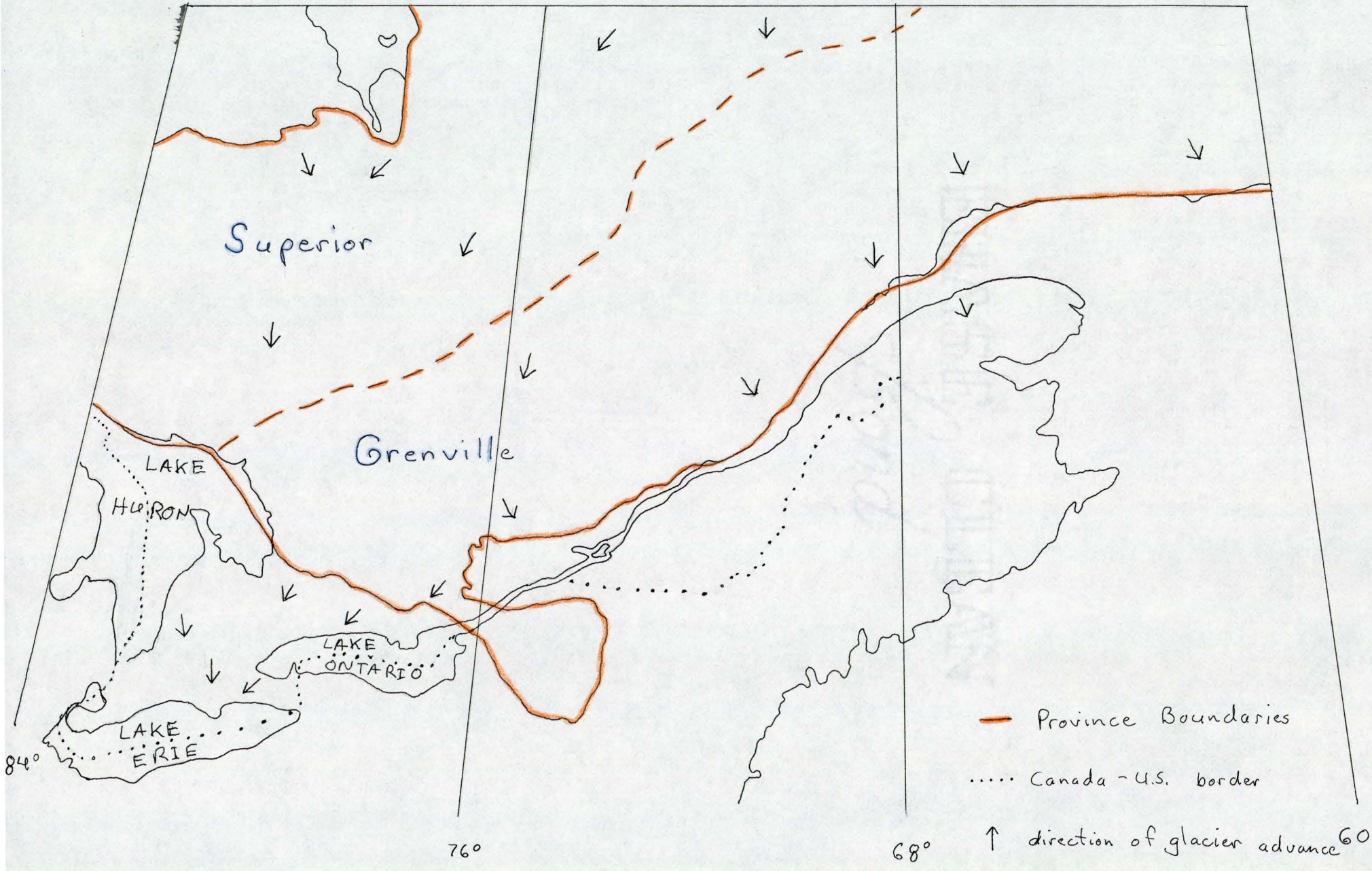
During late Wisconsin time, the Laurentide Ice Sheet (a type of glacier) was flowing south. It flowed down through Canada to the United States. Lobes formed from the ice sheet because physical structures on the earth, such as hills, valleys, and mountains, deflected the ice or because of the ice flowing at different speeds or directions. The Ontario and Erie Basins had directed the main ice westward past Mississippian-Pennsylvanian sandstone of the escarpment of low Appalachian Plateaus. Sub-lobes of ice pressed southward from this mainstream into the sandstone hills of the eroded plateau, forming short lobes over northwest Pennsylvania and northeast Ohio. One of these lobes was called the Erie Lobe and was in northern Ohio. This lobe split around the bedrock hills of Ohio to form the Miami Lobe

to the west and the Scioto Lobe to the east. The bedrock hills were ultimately also covered by ice. The lobe that I'm interested in which is also the one that Marion County is in is the Scioto Lobe (see map, page 10). When a glacier retreats it leaves debris. This comes from the material within the glacier being deposited as the glacier melts and from streams formed by the waters of the melting ice. This debris piles up at the front of the glacier and is called a moraine. Within this debris are the erratics. They usually come from various bedrock within Canada. The erratic that is at the Marion Branch Campus of Ohio State University and most within the moraine around Marion Branch Campus of Ohio State University came from the Grenville Province in Canada (see map, page 11). A moraine that is in Marion County and also is around Marion is the St. Johns Moraine. It used to be called the Mount Victory Moraine because it is well developed from Mount Victory in southeastern Hardin County eastward to the meridian of Marion. The St. Johns Moraine is the northernmost moraine that is crossed by the Scioto River north to Columbus. This moraine is a minor moraine of the Late Wisconsin Stage. This morainic system does not have such long continued distinct belts of boulders as characterize the equivalent system of the Miami Lobe, but it is nevertheless liberally strewn with them throughout the greater part of its course. The area around the Marion Branch Campus of Ohio State University does not have very many because they were moved for either farming or building purposes. The morainic knolls seldom exceed 15 feet and the



Map # 5

shows the Erie Lobe, other sublobes, and the direction the glacier advanced in Ohio



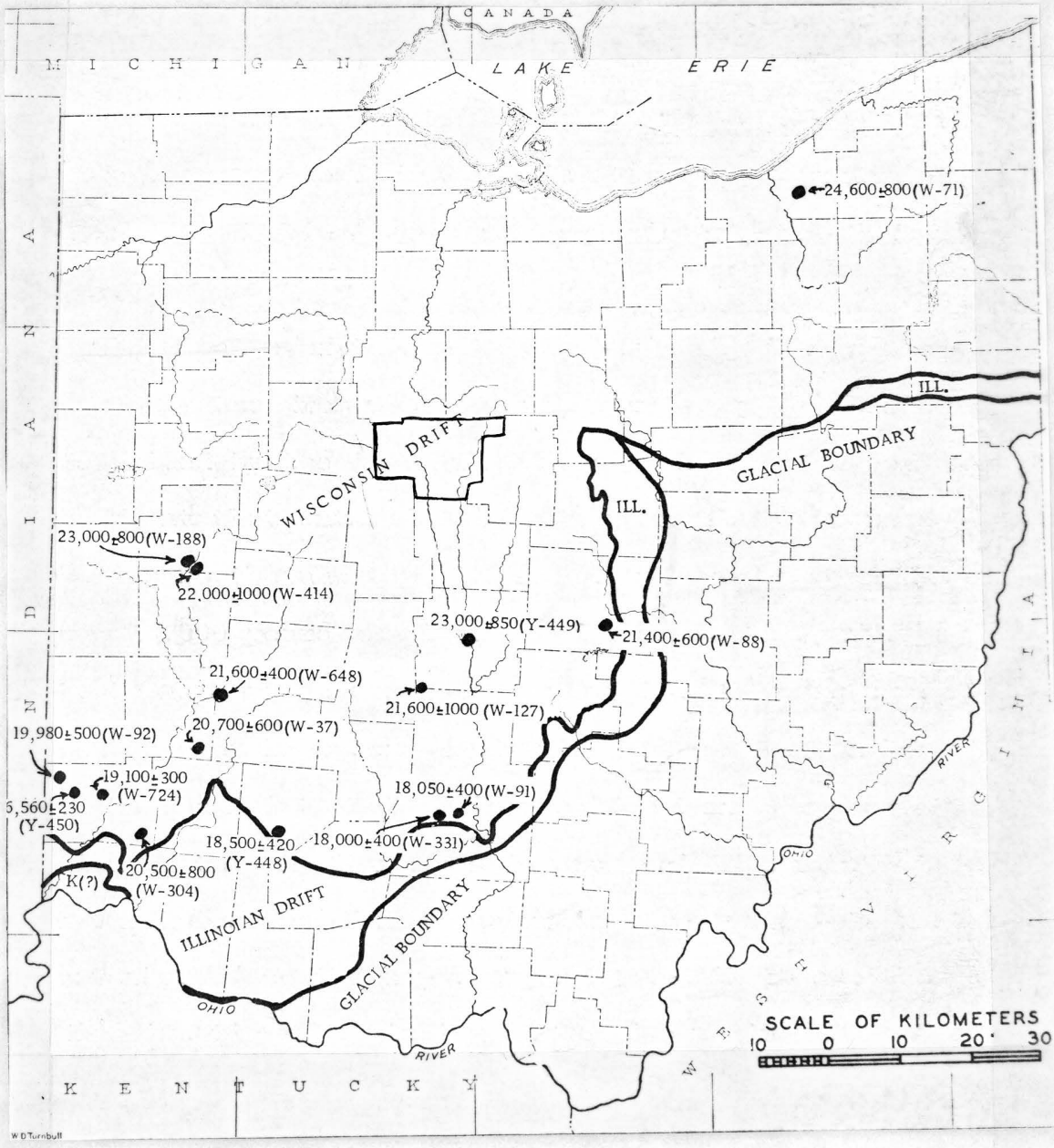
shows the direction the glacier advanced in the Superior and Grenville Provinces of Canada

Map # 6

majority fall below 10 feet in height. The boulders that dot the surface are up to 6 feet in diameter. The erratic at Marion Branch Campus of Ohio State University is at least 6 feet in diameter.

The advance of this Late Wisconsin glacier is recorded by radiocarbon dates from wood (mostly Spruce, Picea) buried in the till deposited by the ice. The dates tell the story of an advancing ice front that entered Ohio more than 25,000 years ago and reached its southernmost position 20,000 years ago in the Miami Lobe and 18,000 years ago in the Scioto Lobe (see map, page 13). The St. Johns Moraine was formed about 14,800 years ago. With these dates overall rates of advance for the ice can be calculated. In the Scioto Lobe this was 15 meters per year. The direction of the glacier advancing was mainly south, but because of all the lobes the directions radiated outward both westerly and easterly. (See the maps, pages 10 and 11 to see the specific direction the glacier advanced both in Ohio and across the Grenville Province in Canada.)

Late Wisconsin drift mantles most of glaciated Ohio. Three different Late Wisconsin tills are recognized on the till plains of Ohio. Each till has a characteristic soil developed in it, of a distinctive texture and color. The northernmost till (Morely and St. Clair or Clyde Silt Loam or Blount-Pewamo) has a relatively high clay content. The high amount of clay is believed to have originated in a series of ice-front lakes during a brief retreat called the Lake Erie interval; it was then incorporated



Map # 7

shows important radioactive dates found in Late Wisconsin till in Ohio

in the till by a subsequent readvance of the glacier. The other two tills were deposited south of Marion County, so are not considered in this report. Soils have been one of the most valuable tools for the glacial geologist in Ohio, being used both for the recognition of different ages of glacial deposits and in the identification of subtle, but apparently significant differences in the composition of the deposits. Most of the soils in Marion County formed in a limy clay loam glacial till. A few soils formed in deposits of glacial lake-laid silt and clay. The dominant soils are light colored, somewhat poorly drained and occupy the gently sloping knolls and ridges. The other soils are dark colored, very poorly drained and occur on the nearly level flat area. The erratic of this report occurs on the latter type soil. This soil has been formed through the weathering under swampy conditions of glacial debris. The upper part has a bluish-black color down to a depth of 9 to 10 inches. The lower subsoil is a gray, plastic silty clay loam to silty clay streaked with yellow. At 30 to 36 inches a mottled yellow and gray, more or less friable silty clay loam is encountered. With increase in depth the yellow becomes more prominent and the texture more friable. This soil is comparatively uniform although in some areas the surface soil is only about 6 inches deep. This silty clay loam occurs southeast, east, and northeast of Marion. This soil occurs more or less continuous areas representing depressions between areas of higher lying types.

A brief summary of the history of the erratic begins with the erratic as part of the bedrock in the Grenville Province in Canada. The Laurentide Ice Sheet picks it up and carries it towards Ohio. It passes on to sublobes of ice (both the Erie and Scioto) and is finally deposited on the St. Johns Moraine about 14,800 years ago. It has laid there ever since that time and probably will stay there longer than the Marion Branch Campus of Ohio State University.

Petrographic Study

In this petrographic study, I will include a description and purpose of a thin section, a brief description of how to make a thin section, a report on the thin section, and an estimated weight for the erratic based on the size and density of it.

A thin section is a piece of rock that has been mounted on a microscopic slide and ground down to about 3 microns (0.03 mm) in thickness. It is ground this thin so light can pass through it. The different minerals will refract light in different ways because of their varying atomic arrangement. When viewed under a microscope the different minerals can be studied, a list of the property of each one is made, and the composition of the rock containing these minerals can be determined. Classes of rocks are determined according to these compositions and names are assigned to the rocks within each class. The microscope normally used for this type of study is a petrographic microscope. It is equipped with polarizers to polarize the light coming through the thin section, a rotating stage, slots for accessory equipment,

and various lens so as to provide diverging or converging light to the thin section.

To make a thin section you need only a small piece of the rock because it need only cover a microscopic slide, which is about 1 inch by 2 inches. This piece of rock must have a flat surface to mount it on the slide. To get this flat surface you first cut the piece of rock with a saw. Now you have a flat surface, but the saw leaves grooves in it so it has to be polished or ground smooth. You can do this by hand, using a plate glass and grit, or you can use a lap wheel. The last grit should be at least as fine as 600 mesh. Now the piece can be mounted to the slide. For this to hold well you must use something very strong. I used an epoxy cement, but there are other substances which work as well. After the epoxy has set you again use a saw to cut the piece of rock down to wafer-thin size. You then use a lap-wheel to grind the section down to about the proper thickness. You can usually tell when this point is reached because you can start seeing through the section. Now you have to use a 600 mesh or 1200 mesh grit and a plate glass to put the final touches on it. As you polish the section, frequently wash it off and observe it under a microscope. You do this until the desired thickness is obtained. This is done by observing the color given off by a mineral that you know and know the color that it should give at the right thickness. Finally, a cover glass is put on the section. I used the same epoxy as I mounted the section with. A cover glass, water, or a certain kind of oil on top of the section is necessary to observe the minerals correctly. There

is a slab of the erratic ready to mount on a microscopic slide and a thin section of the erratic on page 18.

Thin Section Report

First I looked at a freshly broken hand specimen to get an idea of what is inside. Many times the outside surface is so weathered that it doesn't show the real mineral content inside. The hand specimen looked like a medium to coarse-grained dark to medium gray-brown diorite with some quartz and dark mineral. The quartz didn't seem to be abundant enough to classify this rock as a granodiorite. The luster is somewhat earthy, but with all of the plagioclase feldspar faces it appears semi-glossy when held certain ways in the light. The grains all appear to be about the same size, so the rock is equigranular. The plagioclase grains show the characteristic twinning striations very well. Some are visible even without a hand lens. The dark minerals are very minute and are probably magnetite-ilmenite. Most of the rock appears to be plagioclase feldspar. Under the microscope the rock is practically all plagioclase. Many grains have sutured edges and bent twin lamellae. The plagioclase comes in about as many different looking ways as it can in this rock. Some do not show twinning, some show much twinning, and some show antiperthitic structure. Under crossed nicols, the clinopyroxene shows up well because it is so bright and everything else is gray. Even in normal light it shows up well because of the difference in relief with the rest of the rock and because it is green while

Section of rock ready to mount on a microsopic slide

Thin section cut, polished and has a cover slip. Ready for study

all the plagioclase is colorless. The clinopyroxene I found to be augite. The opaque minerals are magnetite-ilmenite. The grains are very small and appear mostly along with the clinopyroxene. The composition of the plagioclase, estimated by the Michel-Levy method, is $Ab_{56}An_{44}$. This would mean that it is Andesine. The rock is estimated to be about 98% andesine. The other 2% is clionopyroxene and magnetite-ilmenite. I found no quartz. Every time I thought I had some it turned out to have the wrong optical properties. The name for this type of rock is anorthosite.

Weight of the Erratic

The density of anorthosite is about 2.8 g/cm^3. This is 2.8 times as heavy as water. One gallon of water weighs 8.00 lbs. There are 7.48 gallons of water in a cubic foot of space. Therefore, one cubic foot of the anorthosite weighs 8.00 x 7.48 x 2.8 = 167 lbs/ft^3. The diameter of the erratic is about 6.0 feet. The volume is found with the formula volume = $4 \pi r^3/3$. The radius (r) = 3.0 feet, therefore, the volume of the erratic is approximately 116.6 cubic feet. Using the volume (116.6 cubic feet) multiplied by the density (167 lbs/cubic foot) you obtain the weight. This is 19,500 lbs. Since there is 2000 lbs. in a ton, this erratic weighs 9.75 tons.

Acknowledgments

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